Original communication

Accuracy of estimation of dental age in comparison with chronological age in Indian population — A comparative analysis of two formulas

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ABSTRACT

Demirjian's 8-teeth method widens the assessment in a wider age group, in comparison with the original 7-teeth method.

Aim and objective: Evaluate age in children, adolescents and young adults using Demirjian's 8-Teeth Method in an Indian population. Compare the effectiveness of existing Demirjian's formula with that of the Indian formula.

Materials and method: Panoramic radiographs of 50 male and 50 female patients aged between 5 and 24 years were collected. The radiographs were interpreted using Demirjian's 8-teeth method and the dental age calculated using Demirjian's formula and the Indian formula. Both the formula's were compared using paired 't' test (SPSS Statistics 11.5).

Results: Among the 100 samples the mean chronological age in 50 males was 13.44 years and mean chronological age in 50 females was 13.12 years. By using Demirjian's formula the mean dental age in male was 11.81 years and that in female was 11.58 years. By using Indian Formula the mean dental age in male was 13.54 years and that in female was 14.06 years. The mean dental age by both the formulas were compared with the corresponding chronological age. It was evaluated that the Demirjian's formula underestimated the mean dental age by 1.63 years in males and by 1.54 years in females, whereas a variation of 0.10 years in male and 0.94 years in female was found with the Indian formula. The mean dental age obtained using Indian formula was approximating with the chronological age in the male and female by a margin of 0.94 years.

Conclusion: Acharya's Indian formula is more effective in evaluating the dental age closer to the chronological age of an individual in an Indian population in comparison with the existing Demirjian's formula.

1. Introduction

Radiology plays an indispensable role in human age determination.[1] The application of radiology in forensic sciences was introduced in 1896, just one year after the discovery of the X-ray by Roentgen, to demonstrate the presence of lead bullet inside the head of a victim.[2] Since 1982, dental radiography, a non destructive and simple technique used daily in dental practice, has been employed in method of age estimation. Dental findings assessed by radiography are an important source of information in forensic odontological age determination.[3] The anticipated developmental sequence that human dentition follows to reach complete development can be utilized in age determination.[4] The method based on the stages of tooth formation as appreciated on radiographs seem to be more appropriate in the assessment of age than those based on skeletal development as the dental development and calcification is controlled more by genes than by environmental factors.[4,5,17,18] The age assessment methods are relatively simple and involve the identification of the stage of mineralization on radiographic images followed by their comparison with the standard stage to estimate the approximate age range.[4,19,20]

The aim of this study was to evaluate age in Children, Adolescents and Young Adults using Demirjian's 8-Teeth Method[6] in an Indian population and to compare the effectiveness of the existing Demirjian's formula with that of the Acharya's Indian formula.

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Table 1
Mean age values using Demirjian's and Indian formula.

	Gender	N	Mean
Original age in years − chronological age	Male	50	13.44
	Female	50	13.12
Demirijian formula − dental age	Male	50	11.8118
	Female	50	11.5888
Indian formula − dental age	Male	50	13.5460
	Female	50	14.0624

2. Materials and method

2.1. Sample distribution

The study samples comprised of 100 panoramic radiographs were collected from the department of Ragas Dental College and Hospital, Chennai, Tamil Nadu, India. All of these films had been taken previously for routine diagnostic purpose so they were being reused. The sample included 50 male and 50 female aged between 5 and 24 years. This age group was included in the study as it has become imperative to determine the correct age in this age group in order to aid in juvenile convictions for criminal offences and other court convictions and to eliminate any age based malpractices in the fields of sports and education.

2.2. Inclusion and exclusion criteria

Good quality dental panoramic tomographs belonging to subjects who were of southern Indian ethnicity were included. Patients with full complement of teeth in the right and left side of mandible were included. If a tooth in the third quadrant of the mandible was missing, then the contra lateral tooth on the other side was included. Patients with developmental anomalies, crowding of teeth and bilaterally missing teeth in the mandibular arch and panoramic radiograph which were distorted were excluded.

2.3. Demirjian staging of tooth developmental stages and scoring method

In this study the 3rd quadrant in the radiograph was accessed visually from mandibular central incisor to the 3rd molar using the Demirjian's modified criteria which included 10 developmental stages instead of 8 developmental stages. The stages were then entered into a separate scoring proforma following which the sex specific maturity score for each tooth was entered depending on the scoring grade.

Calculation of chronological and dental age.

The following two formulas were used to evaluate the dental age, namely:

Demirjian's Formula[6]:

Acharya's Formula- India-specific formula[8]:

$$\text{Males}: \text{Age} = 27.4351 - (0.0097 \times S^2) + (0.000089 \times S^3)$$
$$\text{Females}: \text{Age} = 23.7288 - (0.0088 \times S^2) + (0.000085 \times S^3)$$

The value so obtained was designated as the dental age calculated using both Demirjian's formula and Acharya's India specific formula. The chronologic age of the patient was obtained from the date of birth record retrieved from the patient database.

2.4. Statistical tests

Data were analyzed using the statistical analysis computer software (SPSS, statistical software Version 11.5). Paired *t*-test was used to analyze the differences between the estimated Dental age and Chronological age separately for Demirjian's formula and the Acharya's India specific formula. The paired *t*-test was used to compare both the formulas.

3. Result

Among the 100 samples the mean chronological age in 50 males was 13.44 years and mean chronological age in 50 females was 13.12 years. By using Demirjian's formula the mean dental age in male was 11.81 years and that in female was 11.58 years. By using Indian Formula the mean dental age in male was 13.54 years and that in female was 14.06 years. The mean dental age by both the formulas were compared with the corresponding chronological age. It was evaluated that the Demirjian's formula underestimated the mean dental age by 1.63 years in males and by 1.54 years in females, whereas a variation of 0.10 years in male and 0.94 years in female was found with the Indian formula. The mean dental age obtained using Indian formula was approximating with the chronological age in the male and female by a margin of 0.94 years (Table 1 Table 2 Table 3 Table 4). Statistical analysis did not yield any significant statistical variation ($p > 0.05$) using Indian formula in all the samples.

4. Discussion

Demirjian[14,15] and his co-workers derived the initial dataset in 1973 and later updated the dataset with additional samples, both belonging to French-Canadian populations. Our study evaluated the applicability of the original dataset by Demirjian et al on Indian population. This study has demonstrated the inapplicability of the Demirjian formula in estimating the dental age of Indians. Ashith B. Acharya (2010)[8] in his study used the 8-teeth method in 547 Indians (199 males and 348 females); aged 7–25 years discussed

$$\text{Males}: \text{Age} = (0.000055 \times S^3) - (0.0065 \times S^2) + (0.0088 \times S) - 8.4583$$
$$\text{Females}: \text{Age} = (0.0000615 \times S^3) - (0.0106 \times S^2) + (0.6997 \times S) - 9.3178$$

Table 2
All Samples-"*t*" test-paired sample test.

	Paired differences					*t*	df	Sig. (2-tailed)
	Mean	Std. deviation	Std. error mean	95% Confidence interval of the difference				
				Lower	Upper			
Original age in years - Demirjian formula	1.5797	2.24001	0.22400	1.1352	2.0242	7.052	99	0.000
Original age in years - Indian formula	−0.5242	2.78416	0.27842	−1.0766	0.0282	−1.883	99	0.063
Demirijian formula - Indian formula	−2.1039	1.51553	0.15155	−2.4046	−1.8032	−13.882	99	0.000

Table 3
Female- "t" test- paired sample test.

	Paired differences					t	df	Sig. (2-tailed)
	Mean	Std. deviation	Std. error mean	95% Confidence interval of the difference				
				Lower	Upper			
Original age in years − Demirijian formula	1.5312	2.36519	0.33449	0.8590	2.2034	4.578	49	0.000
Original age in years − Indian formula	−0.9424	2.95137	0.41739	−1.7812	−0.1036	−2.258	49	0.028
Demirijian formula − Indian formula	−2.4736	1.51125	0.21372	−2.9031	−2.0441	−11.574	49	0.000

Table 4
Male- "t" test-paired sample test.

	Paired differences					t	df	Sig. (2-tailed)
	Mean	Std. deviation	Std. error mean	95% Confidence interval of the difference				
				Lower	Upper			
Original age in years − Demirjian formula	1.6282	2.13044	0.30129	1.0227	2.2337	5.404	49	0.000
Original age in years - Indian formula	−0.1060	2.56784	0.36315	−0.8358	0.06238	−0.292	49	0.772
Demirijian formula - Indian formula	−1.7342	1.44143	0.20385	−2.1438	−1.3246	−8.507	49	0.000

the effectiveness of original formula and Indian formula. The study concluded that the cubic functions by Chaillet and Demirjian yielded the best fit for French population and same cubic functions misclassified in Indian sample. Considering the wide variations, regression analysis was performed for the Indian sample to derive India-specific formulas. The test of the India-specific cubic functions and the original formulas revealed better ability of the former to predict age accurately in Indians lending weight to the development of population-specific standards for the 8-teeth method as well. The Indian formulas resulted in an MAE that was close to a half year less than the original formulas and also ability to predict age "accurately". Ashith B. Acharya[8] in his study found that the Demirjian's formulas resulted in inferior age prediction in Indians. India-specific regression formulas gave better age estimates (mean absolute error, MAE = 0.87 years) than the original formulas (MAE = 1.29 years). This is in accordance with our age estimates in Indian population this suggested that the Demirjian's 8-teeth method also needs adaptation prior to use in diverse populations.

V. Jayanth Kumar, K. Saraswathi Gopal (2011)[7] showed that the mean absolute error for the study sample was 1.18 years and in 57.9% of cases in their study the error rate was within ±1 year. The mean absolute error in males aged between 7 and 16 years was 1.2 years and in males aged between 16.1 and 23 years was 1.3 years. In females aged between 7 and 16 years was 0.95 years and in females aged between 16.1 and 23 years was 1.16 years. The age estimation using this method narrows down the error rate to just over one year making this method reliable. However the inclusion of third molar in their study increased the error rates in the older individuals within the sample.

J. Jayaraman, N. M. King (2011)[9] using the Demirjian's formula had calculated the dental age in old southern Chinese population. There was a mean overestimation of dental age of 0.62 years for boys ($p < 0.01$) and 0.36 years for girls ($p < 0.01$). Demirjian's dataset is not suitable for estimating the age of 3–16 years old southern Chinese children. Genetic influences, socio-economic status, nutritional conditions, dietary habits and climatic conditions of the habitat have been reported as possible reasons for variations in skeletal and dental maturity among different populations and ethnic groups.[10–13,16]

5. Conclusion

In conclusion, Acharya's Indian formula is more effective in evaluating the dental age closer to the chronological age of an individual in an Indian population in comparison with the existing Demirjian's formula in this study. However a far larger sample size representing all groups would be required to draw any solid inferences for the population as a whole. This only implies that Demirjian's 8-teeth method has to be suitably adapted for use in diverse population. The sex maturity score used in male and female for the French population only has been used till date in an Indian population, necessitating the development of an India specific sex maturity score to be used in an ethnic population.

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